X/149

MODEL LSA

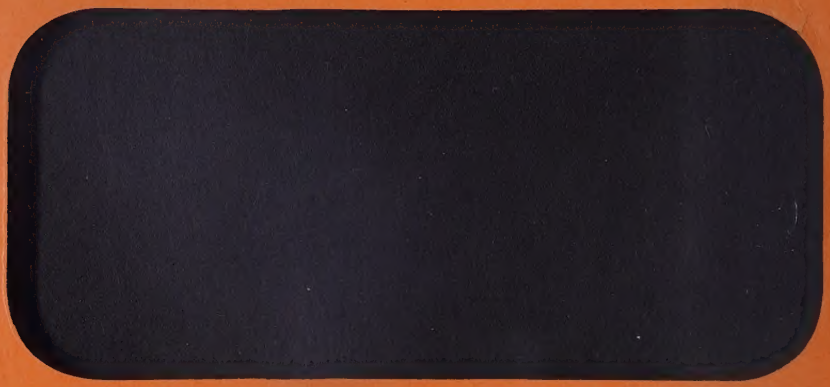
ALL BAND, DIRECT READING

SPECTRUM ANALYZER

10 Mc — 21,000 Mc

Polarad
Electronics Corporation

100 METROPOLITAN AVENUE BROOKLYN 11, N. Y.



X/149
MAR 1 1954

INSTRUCTION MANUAL — PART ONE

MODEL LSA

ALL BAND, DIRECT READING

SPECTRUM ANALYZER

10 Mc — 21,000 Mc

DESCRIBING

SPECTRUM DISPLAY UNIT, MODEL LDU-2A
KLYSTRON POWER UNIT, MODEL LKU-2A
POWER UNIT, MODEL LPU-2

August 3, 1953
Issue E-

POLARAD ELECTRONICS CORP.
100 METROPOLITAN AVE.
BROOKLYN 11, N. Y.
STagg 2-3464

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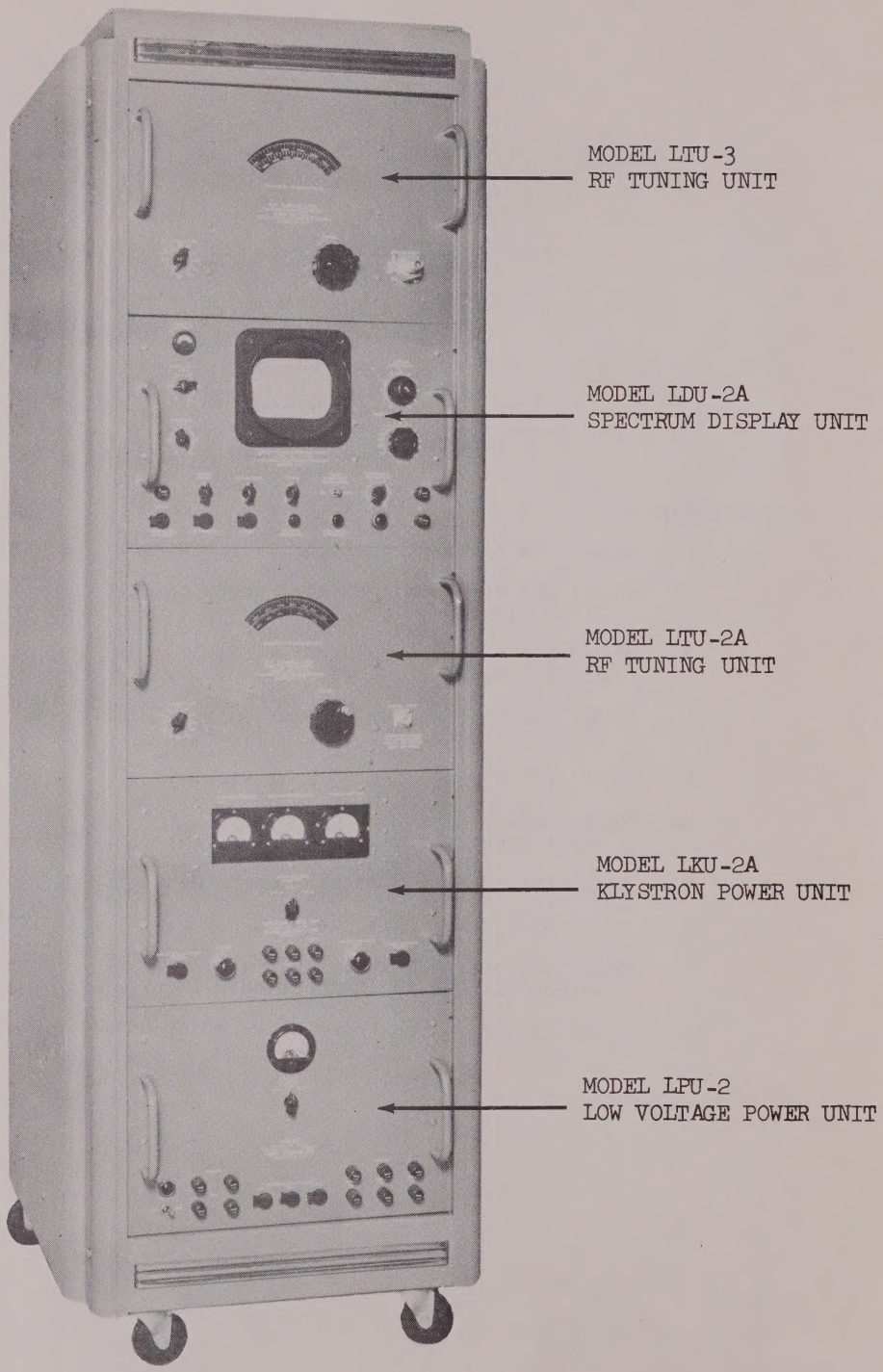


FIGURE 1. MODEL LSA SPECTRUM ANALYZER
FRONT VIEW.

PART I. THE POLARAD MODEL LSA

SPECTRUM ANALYZER

SECTION I. GENERAL DESCRIPTION

1. PURPOSE AND ORGANIZATION OF MANUAL.

a. This instruction manual relates to the Model LSA All-band Direct-reading Spectrum Analyzer, covering the frequency range from 10 mc to 21,000 mc, designed and manufactured by the Polarad Electronics Corporation of Brooklyn, N.Y. The manual describes the electrical and mechanical features of the three basic units of the equipment, the Model LDU-2A Spectrum Display Unit, the Model LKU-2A Klystron Power Unit, and the Model LPU-2 Power Unit.

b. Since the Model LSA Spectrum Analyzer consists of several major units, it has been found desirable to divide the book into five major parts, to provide the most concise organization and presentation of the material. Part I, the present manual, contains descriptive and maintenance data for the basic units of the Spectrum Analyzer, which consist of the Model LDU-2A Display Unit, the Model LPU-2 Power Unit, and the Model LKU-2A Klystron Power Unit. Part II of the manual provides complete operational and adjustment data for the Model LTU-1 RF Tuning Unit, covering the frequency range from 9.5 mc to 1200 mc. Part III is an operating and service manual for the Model LTU-2A RF Tuning Unit, covering the frequency range from 940 mc to 4500 mc, Part IV is applicable to the Model LTU-3 RF Tuning Unit covering the 4460 mc-16,520 mc frequency range, while Part V applies only to the Model LTU-4 RF Tuning Unit with a frequency coverage from 15,000 mc to 21,000 mc.

2. USES OF THE SPECTRUM ANALYZER.

a. Polarad's Model LSA Spectrum Analyzer is a laboratory instrument which is used to provide a visual indication of the frequency distribution of energy in an rf signal in the range covered by the Tuning Unit in use. The four RF Tuning Units receive cw and pulsed radio signals in the frequency range from 10 mc to 21,000 mc, and converts them to an intermediate frequency of 160 mc, at a power level sufficient to drive the various circuits located within the Model LDU-2A Spectrum Display Unit. Signals detected are presented visually as a plot of voltage, on the vertical axis, versus frequency on the horizontal axis, on a 5-inch cathode ray tube screen in the Spectrum Display Unit. Controls are Provided on the Display Unit front panel for observing on the screen a band of frequencies as narrow as 250 kc, adjustable continuously to a band as wide as 25 mc, as desired.

b. Specific uses of the equipment are:

(1) Observing and measuring side bands associated with amplitude and frequency modulated signals;

(2) Determining the presence and accurately measuring the frequency of radio and/or radar signals;

(3) Determine type of modulation in radio and/or radar signals in any particular band;

(4) Checking and observing the tracking of rf components of a radar system, example, tracking transmitter and receiver;

(5) Determining rf pulse characteristics:

a. Frequency modulation
b. Pulse width
c. Pulse shape

} By Spectrum Analysis

(6) Checking the spectrum of pulsed magnetron oscillators, to determine pulse characteristics and check frequency pulling;

(7) Measure noise spectra;

(8) Checking the frequency difference of two close rf signals;

(9) Checking frequency relationships of multi-frequency transmitters, example, dmb transmitters;

(10) Comparing two pulses at same time;

(11) Checking for spurious response;

(12) Testing for interference sources throughout frequency range from any electrical equipment;

(13) Checking transmitter or signal generator for continuous output throughout band (checking for "holes");

(14) Drift of incoming signals;

(15) Leakage;

(16) Indicator for freq. standards (such as L band).

3. MAJOR UNITS.

a. Figure 1 shows the three basic units of the Model LSA Spectrum Analyzer and two of the RF Tuning Units mounted within the deluxe steel cabinet rack supplied with the equipment. The major units are:

Polarad Model No.	Item	Description
LPU-2	Power Unit	Provides all the low voltage D.C. and A.C. power requirements of the system. The +105, +105 and +300 D.C. voltages are electronically regulated and adjustable, with outputs monitored on the unit's front panel meter. The -150v D.C. voltage is referenced by the VR tubes.
LKU-2A	Klystron Power Unit	Provides the proper regulated voltages and the time delay for the application of these voltages to the klystron oscillators used in the Model LTU-2A LTU-3 and LTU-4 Tuning Units. Anode and reflector voltages for the klystron tube are adjustable, with outputs monitored on front panel meters. (Not required for operation of the Model LTU-1 RF Tuning Unit.) The proper voltage is applied by setting the meter switch on the front panel to the desired unit.
LDU-2A	Spectrum Display Unit	Provides visual means for resolving and measuring accurately the spectrum of a radio frequency signal, within the range covered by the Tuning Unit in use. A variable frequency marker permits determination of frequency differences of as little as 250 kc, or as much as 25 mc.
LTU-1	RF Tuning Unit	Provides frequency coverage over the range from 9.5 mc to 1200 mc.
LTU-2A	RF Tuning Unit	Provides frequency coverage over the range from 940 mc to 4500 mc.
LTU-3	RF Tuning Unit	Provides frequency coverage over the range from 4460 mc to 16,520 mc.
LTU-4	RF Tuning Unit	Provides frequency coverage over the range from 15,000 to 21,000 mc.

b. All interconnecting cables are supplied with the basic units of the Spectrum Analyzer. These cables are:

Part No.	Cable Description	Function
W1	Input power.	Connects Model LPU-2 Power Unit to 50/60 cps, 105-125 V, power source.
W2	Tuning Unit power.	Connects output of Model LPU-2 Power Unit to the Tuning Unit in use. In using the Model LTU-2A the Model LTU-3 or the Model LTU-4 RF Tuning Unit, cable W2 supplies 115-volt 50/60 cps input to Klystron Power Unit, Model LKU-2A.
W3	Display Unit power.	Connects output of Model LPU-2 Power Unit to Model LDU-2A Spectrum Display Unit.
W4	Klystron Power.	Connects Klystron Power Unit to the Model LTU-2A LTU-3, or LTU-4 RF Tuning Unit. Input power to the Klystron Power Unit is supplied via cable W2; regulated output from the Klystron Power Unit is applied to the external-cavity klystron-oscillator within the Tuning Unit.
W5	Display Signal.	Connects the 160-mc amplified output of the rf. Tuning Unit to if. circuits within the Spectrum Display Unit, Model LDU-2A.

c. The cabinet rack is mounted on casters, permitting the equipment to be easily moved. (Rack Handle, which was removed for ease in shipping, is located on back door of rack.)

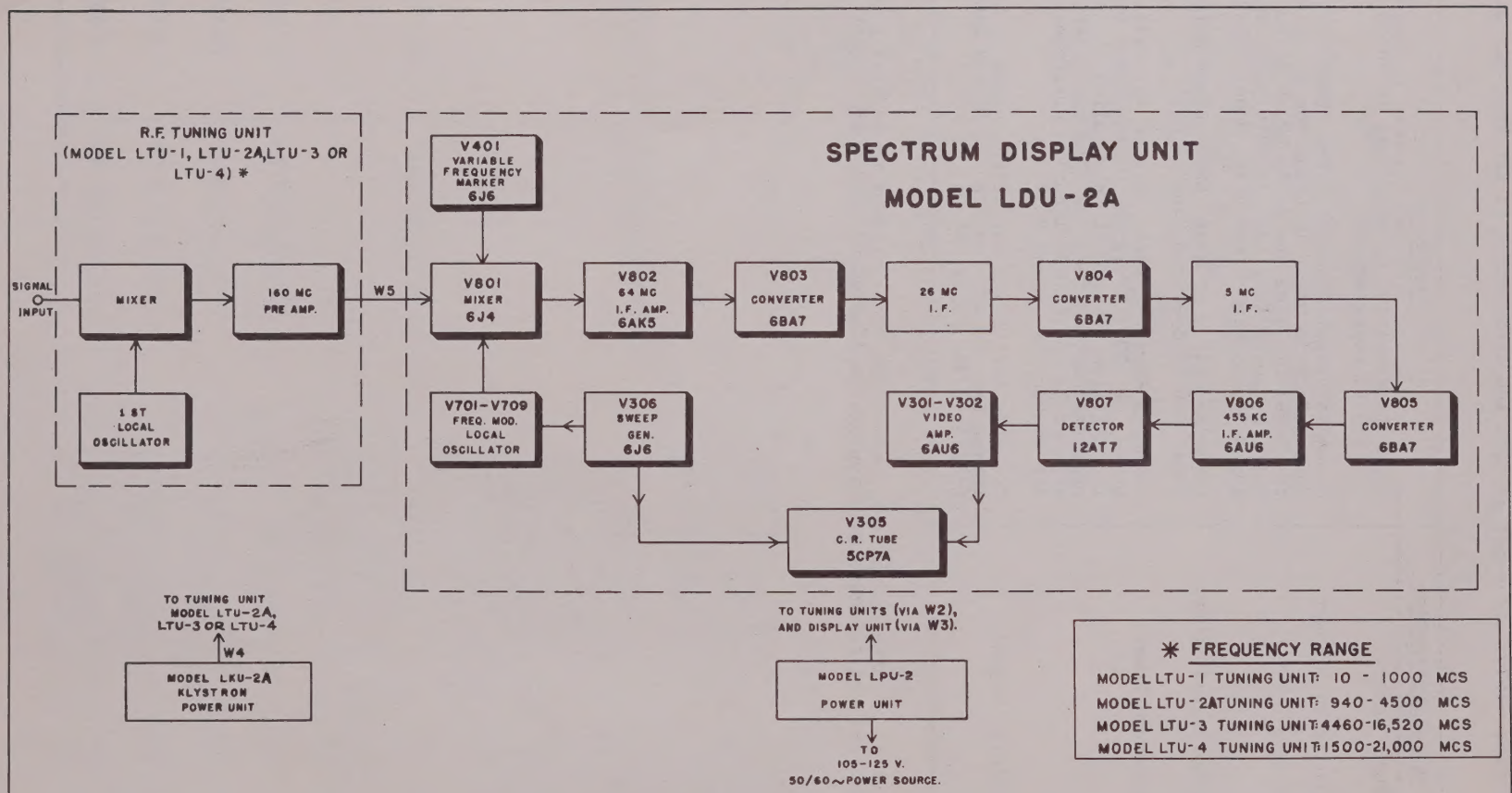

R.F. TUNING UNIT
(MODEL LTU-1, LTU-2A, LTU-3 OR LTU-4) *
SIGNAL INPUT
MIXER
160 MC PRE AMP.
1 ST LOCAL OSCILLATOR
W5
V401 VARIABLE FREQUENCY MARKER 6J6
SPECTRUM DISPLAY UNIT
MODEL LDU-2A
V801 MIXER 6J4
V802 64 MC I.F. AMP. 6AK5
V803 CONVERTER 6BA7
26 MC I.F.
V804 CONVERTER 6BA7
5 MC I.F.
V805 CONVERTER 6BA7
V806 455 KC I.F. AMP. 6AU6
V807 DETECTOR 12AT7
V301-V302 VIDEO AMP. 6AU6
V305 C.R. TUBE 5CP7A
V306 SWEEP GEN. 6J6
V701-V709 FREQ. MOD. LOCAL OSCILLATOR
TO TUNING UNIT MODEL LTU-2A, LTU-3 OR LTU-4
W4
MODEL LKU-2A KLYSTRON POWER UNIT
TO TUNING UNITS (VIA W2), AND DISPLAY UNIT (VIA W3).
MODEL LPU-2 POWER UNIT
TO 105-125 V. 50/60~ POWER SOURCE.
* FREQUENCY RANGE
MODEL LTU-1 TUNING UNIT: 10 - 1000 MCS
MODEL LTU-2A TUNING UNIT: 940 - 4500 MCS
MODEL LTU-3 TUNING UNIT: 4460-16,520 MCS
MODEL LTU-4 TUNING UNIT: 1500-21,000 MCS

FIG. 2
MODEL LSA SPECTRUM ANALYZER
FUNCTIONAL BLOCK DIAGRAM

SECTION II

SPECTRUM DISPLAY UNIT

MODEL LDU-2A

1. PHYSICAL FEATURES.
(Refer to Figure 3.)

a. The Model LDU-2A Spectrum Display Unit is housed on a metal chassis having overall dimensions of 12-1/4 inches high by 19 inches wide by 21-3/4 inches deep, as measured from the rear of the chassis to the handles on the equipment front panel.

FIGURE 3. MODEL LDU-2A SPECTRUM DISPLAY UNIT, FRONT VIEW.

2. ELECTRICAL CHARACTERISTICS.

a. General

The Unit consists of a narrow band amplifier, a variable frequency marker oscillator and a sweeper circuit, all built as sub-chassis, and a 5-inch cathode ray oscilloscope with its associated driving circuit. Figure 2 is a block diagram of the complete spectrum analyzer, (Refer to figure 8 for a schematic diagram of the Display Unit) The Spectrum Display Unit receives a 160 mc signal from the RF Tuning Unit preamplifier. The signal from the preamplifier and the output of the marker are fed into the mixer of the narrow band amplifier. The local oscillator swept injection of the sweeper is also fed into the mixer of the narrow band amplifier, which results in an if frequency of 64 mc which the narrow band will amplify. The last two stages of the narrow band amplifier have a bandwidth of 25 kc which effectively result in a resolution of 25 kc at all input frequencies. In addition to the usual scope controls, means for adjusting the center frequency, and frequency limits of the sweep oscillator are provided. An unusually distinct spectrum display is obtained by beam intensification for the duration of the signal. The variable-frequency marker in the Display Unit can be used to determine frequency differences of as little as 250 kc or as much as 25 mc. It calibrates the spectrum display and helps determine frequency difference with great accuracy. A description of each of the components of the display unit is given below. Their location on the chassis is shown in figure 4.

b. MAJOR OPERATING CIRCUITS.

(1) NARROW BAND AMPLIFIER -- The narrow band amplifier is mounted on the right side frame of the Spectrum Display Unit. The function of the narrow band amplifier is to heterodyne the output of the 160 mc pre-amplifier and the variable frequency provided by the sweeper circuit to produce a 455 kc if. with a 25 kc bandwidth which is amplified and applied to the vertical deflection plates of the oscilloscope. The circuit consists of seven stages, designated tubes V801 through V807. The output of the 160 mc pre-amplifier and the output of the frequency-modulated second local-oscillator (operating at a center-frequency of 224 mc) are applied to the mixer tube V801 and the marker oscillator. A resultant beat frequency of 64 mc is amplified in the second tube V802, and is coupled to the amplifier section of the third stage, which functions as a converter. The oscillator section of tube V803, tuned to 90 mc, mixes with the applied 64 mc signal to produce a 26 mc output. The fourth stage, V804, also functions as a converter, and has its oscillator section tuned to a frequency of 31 mc. As a result of heterodyning, the 5 mc output of the fourth stage is available for application to the final converter, tube V805. In this converter, the oscillator section is tuned to a frequency of 5.455 mc. The resultant 455 kc beat signal is amplified by an if. amplifier tube V806, and is coupled to one section of the 12AT7 twin-diode V807, which functions as a diode detector. This detected output is fed into a cathode follower, the second section of tube V807. The cathode follower is directly coupled to the vertical deflection amplifiers of the oscilloscope. The resolution of the spectrum analyzer is 25 kc, constant at all frequencies, input and sweep, and is determined by the 25 kc bandwidth of the final if. amplifier.

(2) MARKER OSCILLATOR -- The variable-frequency marker oscillator is mounted directly to the right of the cathode-ray tube, as viewed from the front of the equipment. The function of the marker oscillator is to provide a frequency standard for calibrating the spectrum display and to help determine frequency differences. This circuit employs a twin-triode 6J6 tube, designated V401, having a center frequency of 288 mc, with a tuning range 14 mc above and below its center frequency. With the FREQUENCY DIFFERENCE tuning knob set to its zero calibration mark, and with the BEAT FREQUENCY OSCILLATOR toggle switch set to its ON position the oscillator produces an output of 288 mc, which appears as a positive pip on the spectrum display. This pip marks the center of the receiver pass-band, i.e., the frequency to which the tuning unit is set. Rotating the FREQUENCY DIFFERENCE dial causes this marker to move along the frequency scale on the cathode ray tube screen in accordance with its tuning dial calibrations. Since the sweeper circuit is centered to produce an output of 224 mc, and the output of the marker oscillator is also applied to the first mixer stage V801 in the narrow band amplifier, a beat frequency of 64 mc is obtained at the output of the mixer tube. This 64 mc beat signal is amplified and converted to lower if. signals through the remainder of the narrow band to appear as a vertical positive pip on the spectrum display screen. Setting the dial to a position other than its zero setting displaces the pip from the center of the pass-band within a range of ± 14 mc. The amplitude of the marker oscillator output is controlled by the MARKER AMPLITUDE pot located on the display unit chassis below the oscillator.

(3) SWEEPER CIRCUIT -- The sweeper circuit is on a demountable chassis which is attached to the right side frame of the Spectrum Display Unit, directly beneath the narrow band amplifier. The function of the sweeper circuit is to convert the sawtooth wave provided by the frequency center-limit stage into a variable frequency ("frequency dispersion") of the proper

amplitude and center frequency for the first mixer stage of the narrow band amplifier. The circuit consists of nine stages, V701 through V709. Input voltage from the frequency center limit stage V313 (in the oscilloscope circuit) is applied at proper DC level to the first tube V701, a reactance modulator, which drives the sweep-oscillator stage V702. The plate tank of this oscillator plus the reactance of the reactance tube is tuned to a center frequency of 28 mc. The third stage, V703, amplifies this output signal. Tube V704 is an amplifier. The 28 mc signal is then fed to the first frequency double stage V705. The output of this stage is amplified by tube V706, and is then coupled to a second frequency doubler V707, producing an output signal of 112 mc. The third and final frequency doubler stage V708 has its plate tank circuit tuned to a frequency of 224 mc. The last stage, V709, is an output amplifier. The amplified signal is directly coupled by coaxial cable to the input of the narrow band amplifier. Since the driving voltage applied to the reactance modulator stage V701 is a saw-tooth in time, the output of the reactance modulator stage varies linearly in frequency with time. Change in output frequency ("frequency dispersion"), set by means of the front panel FREQUENCY DISPERSION MEGACYCLES control, may be as narrow as 250 kc, or as wide as 25 mc, when the Model LTU-4, Model LTU-3, Model LTU-2, or the 100-1000 mc band of the Model LTU-1 RF Tuning Unit is used with the Spectrum Analyzer. When the 10-100 mc range of the Model LTU-1 Tuning Unit is used, a relay is automatically energized to limit the maximum pass band displayed to 5 mc.

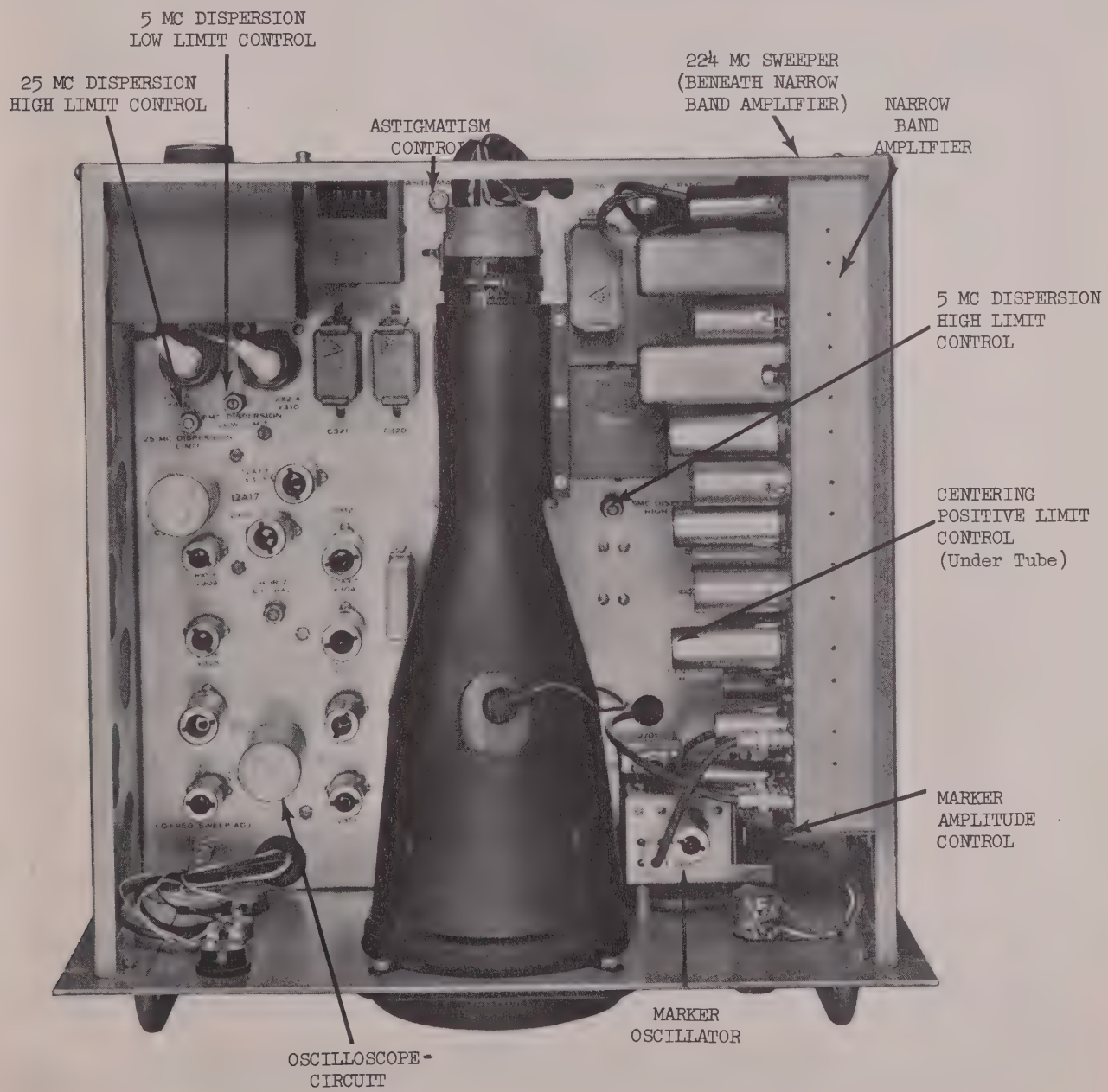


FIGURE 4. MODEL LDU-2A SPECTRUM DISPLAY UNIT, INTERIOR VIEW.

(4) OSCILLOSCOPE CIRCUIT -- The oscilloscope circuit is mounted on the chassis of the Spectrum Display Unit to the left of the cathode-ray tube, as viewed from the front of the unit. The input voltage is fed from the cathode follower section of tube V807 (in the narrow band amplifier) to the grid of V302. Tubes V301 and V302 are connected in such a manner that they both phase invert and amplify the signal, providing a balanced output to the vertical deflection plates of V305, the cathode-ray tube. To obtain the proper d.c. level to balance V301 and V302 the detector section of V807 in the narrow band amplifier is connected to the bleeder network in the grid of V302. A potentiometer is added for final adjustment. This is the VERTICAL D.C. BALANCE pot on the front panel. Part of the output of V302 is fed to the intensifier section of the mixer stage V304 and can be controlled by the INTENSIFIER pot. The amplified output of the tube V304 is coupled to the control grid of the cathode-ray tube V305, and serves to intensify the beam for the duration of the signal. Tube V306 functions as the sweep waveform generator, and its repetition rate may be continuously varied between 3 and 20 cycles per second or synchronized with submultiples of the power line frequency. The output of V306 is fed to one section of twin-triode V307. This section is a cathode follower, the output of which is directly coupled to the grid of V309 through a balance network. The other section of V307 amplifies the pulse, corresponding to the retrace of the sweep, and uses it to trigger the blanking pulse generator V303. This stage functions as a one-shot multivibrator. The blanking pulse output of this tube is fed through one section of the mixer-amplifier stage V304. The output pulse of this stage is coupled to the control grid of the cathode-ray tube in such polarity that it blanks the electron beam for the duration of the sweep retrace. Tubes V308 and V309 are connected in a manner similar to that of tubes V301 and V302 and both phase invert and amplify the sawtooth waveform providing a balanced sweep signal to the horizontal deflection plates of V305, the cathode ray tube. Tubes V310 and V311 are connected as a voltage doubler rectifier circuit, providing high voltage for the electron gun and accelerator anodes of the cathode ray tube. In addition the synchronizing pulses for the sweep circuit are supplied from a section of the filter of V311. The last two stages of the oscilloscope circuit, V312 and V313, take the output of sweep generator V306 and directly couple it into the reactance tube of the sweeper circuit. This circuit permits independent adjustment of the d.c. level and a.c. amplitude of the sawtooth waveform.

3. OPERATING CONTROLS AND ADJUSTMENTS.

The operating controls and adjustments for the Spectrum Display Unit, Model LDU-2A are:

OPERATING CONTROLS AND ADJUSTMENTS

Control	Location	Function
VERTICAL CENTERING	Front panel.	Shifts the trace up or down on the cathode-ray tube screen.
HORIZONTAL CENTERING	Front panel.	Shifts the trace left or right on the cathode-ray tube screen.
SYNC	Front panel.	Synchronizes the sweep oscillator of the Spectrum Display Unit with submultiples of the power line frequency.
INTENSIFIER	Front panel.	Sets the amount by which the positive signal traces on the cathode-ray tube screen are intensified.
FOCUS	Front panel.	Focuses the trace on the scope screen.
BRIGHTNESS	Front panel.	Sets the general intensity level of the trace on the cathode-ray tube screen.
SWEEP SPEED	Front panel.	Permits adjustment of the repetition rate, within the limits of 3 to 20 cycles per second.
BEAT FREQUENCY OSCILLATOR ON-OFF	Front panel.	Applies operating power to the marker oscillator within the equipment.
FREQUENCY DISPERSION	Front panel.	Varies the number of megacycles displayed.

Control	Location	Function
CENTER FREQUENCY	Front panel.	Controls the center frequency of the sweeper.
FREQUENCY DIFFERENCE	Front panel.	Permits re-locating the marker pip within plus and minus 14 megacycles of center.
VERTICAL GAIN	Front panel.	Varies the gain of the vertical-deflection amplifier and hence the height of the display appearing on the screen.
HORIZONTAL GAIN	Front panel.	Varies the gain of the horizontal-deflection amplifier and hence the length of the trace on the cathode-ray tube screen.
VERTICAL D.C. BALANCE	Front panel.	When properly adjusted, prevents the VERTICAL GAIN control from having a vertical centering effect.
HORIZONTAL D.C. BALANCE	Top of chassis between V312 & C301	When properly adjusted, prevents the HORIZONTAL GAIN control from having an effect on the horizontal center of the beam.
LO-FREQ. SWEEP ADJ.	Top of chassis in left front corner.	Sets sweep rate at low end of sweep frequency.
ASTIGMATISM	Rear center, top of chassis.	Used as a means of obtaining optimum focus of the electron beam over the entire face of the cathode-ray tube screen.
MARKER AMPLITUDE	Top of chassis, right front corner.	Varies the height of the positive marker pip on the screen, when the BEAT FREQUENCY OSCILLATOR switch is set to its ON position.
5 MC DISPERSION LOW LIMIT	Top of chassis, in front of inductor L301.	Sets the minimum number of mc dispersion for the 5 mc dispersion range.
25 MC DISPERSION HIGH LIMIT	Top of chassis, directly in front of tube V311.	Sets the maximum number of mc dispersion for the 25 mc dispersion range.
5 MC DISPERSION HIGH LIMIT	Top of chassis, in front and to the right of tube V311.	Sets the maximum number of mc dispersion for the 5 mc dispersion range.
CENTERING LIMIT	Top of chassis, right side of CRT.	Sets the positive and negative limit of the front panel CENTER FREQUENCY control.
NOISE LEVEL	Top of narrow band amplifier, left of V806.	Adjusts the desired residual noise level in the narrow band amplifier.

4. OPERATION.

a. To determine the frequency of an incoming rf signal:

(1) Connect the RF Tuning Unit that covers the band of frequencies to be scanned and detected, as indicated in figure 2.

(2) Observe that each INPUT jack on the Tuning Units is clearly marked for frequency coverage on the panel. Connect the incoming rf signal cable to the INPUT jack with panel markings showing that the signal falls within the appropriate frequency range.

(3) Rotate the main tuning dial until a pip, representing the incoming rf signal, appears on the screen. If the display is excessively large, vary either the external RF ATTENUATOR (if using the Models LTU-2Aor LTU-3 RF Tuning Unit), the IF ATTENTUATOR, and/or the

VERTICAL GAIN control on the Spectrum Display Unit to control the height of the pip. (Use the VERTICAL GAIN control as a final adjustment).

(4) Adjust the spectrum dispersion by varying the FREQUENCY DISPERSION control, on the Spectrum Display Unit front panel. This dial permits control over the band of frequencies covered by the sweep-oscillator circuit. Frequency dispersion can be varied within the limits of 250 kc to 25 mc, except on the 10-to-100 mc scale of the Model LTU-1 Tuning Unit. On that range, the maximum usable frequency dispersion is 5 mc. When the FREQUENCY DISPERSION control is set to its extreme counterclockwise position, and the HORIZONTAL GAIN control is at the extreme clockwise setting, the display on the screen will be expanded to a dispersion of approximately 5 kc/inch.

(5) Turn the BEAT FREQUENCY OSCILLATOR switch to its ON position. Turn the FREQ. DIFF. control to zero. This operation places the BFO marker pip at the electrical center of the display.

(6) If the marker pip is not visible or is not in the center of the display screen, vary the CENTER FREQUENCY control until the pip is properly centered on the display. The CENTER FREQUENCY dial permits investigation into any portion of the display appearing on the screen, over a band of frequencies that may be as narrow as 250 kc, and as wide as 25 mc, depending upon the setting of the FREQUENCY DISPERSION control, the HORIZONTAL GAIN control, and the Tuning Unit in operation (as explained in step 4, above).

(7) To determine the precise frequency of the incoming rf signal, slowly rotate the main tuning dial on the Tuning Unit in use until the signal pip merges with the marker pip. Read the frequency of the incoming rf signal directly from the dial.

(8) If information concerning the width of any lobe of a signal spectrum appearing on the display is desired, proceed as follows:

(a) Note that the FREQUENCY DIFFERENCE control is calibrated from minus 14 to plus 14 megacycles. Vary the FREQUENCY DIFFERENCE dial so that the marker pip is coincident with the low-frequency edge of the lobe whose width is to be measured. Record the setting of the dial.

(b) Rotate the FREQUENCY DIFFERENCE dial so that the marker pip travels across the display until the pip is coincident with the high-frequency edge of the lobe being measured. Record this setting of the dial.

(c) Calculate the difference in megacycles between the settings of the FREQUENCY DIFFERENCE dial in steps (a) and (b). This figure is the width in megacycles of a particular lobe appearing in the display.

(d) The procedure described immediately above is also applicable to measuring frequency differences between any two signals appearing in the display.

(9) The Spectrum Display Unit is designed to indicate increasing frequency, of input signal from left to right except for the 4460-8500 mc range of the Model LTU-3 Tuning Unit. For that unit, and in that range only, increasing frequency reads from right to left on the display.

(10) It is important to distinguish between the true signal and the image. They can be separated beyond doubt by maintaining the input signal at a fixed frequency and rotating the tuning dial to higher frequencies. In all cases but one, the true signal moves to the left and the image moves to the right. (The exception is the 4460-8500 mc range of Model LTU-3 RF Tuning Unit. In this range the true signal moves to the right. This is the only range in which the signal is 160 mc above the first local-oscillator). On all the other frequency bands of the Spectrum Analyzer, the signal is 160 mc below the local-oscillator. One factor aiding in distinguishing between the true signal and the image is the separation of 320 mc, which places the image relatively far away from the true signal on the frequency scale.

5. SPECIFICATIONS.

Indicator	Type 5CP7A Yellow, long persistance, 5 inch cathode-ray tube.
Spectrum display	Voltage or power on the vertical axis versus frequency on the horizontal axis.
Spectrum resolution	25 kc at all frequencies.

Frequency dispersion.....Adjustable from 250 kc to 25 mc with RF Tuning Unit except on the 10-100 mc band of LTU-1, where it is adjustable from 250 kc to 5 mc.

Sweep repetition rate.....3 to 20 cps, adjustable.

Input signal.....160 mc

Intermediate Frequencies:
Second if.....64 mc
Third if.....26 mc
Fourth if..... 5 mc
Fifth if.....455 kc

Sweeper Circuit.....224 mc ± 12.5 mc

Frequency marker.....288 mc ± 14 mc

Tube complement.....2-2X2A; 8-6AK5; 5-6AU6; 3-6BA7; 2-6J4; 2-6J6; 3-12AT7; 2-12AU7; 1-12AX7; 1-5CP7A; 1-2D21.

Input: DC.....+ 105 V; + 150 V; + 300 V; - 150 V.

AC.....105-125 volts 60 cps; 6.3 volts.

6. MAINTENANCE.

a. MAINTENANCE DATA SUMMARY.

CAUTION

PERFORMANCE DATA OF THE SPECTRUM DISPLAY UNIT DEPENDS UPON THE SETTINGS OF THE CONTROLS. CONTROLS SHOULD BE ADJUSTED AS INDICATED BELOW, BEFORE DATA IS TAKEN.

Control	Setting
FREQUENCY DISPERSION	25 mc. (No. 8 on Dial)
SWEEP SPEED	15 cps.
VERTICAL GAIN	Maximum.
NOISE LEVEL	Full clockwise.
HORIZONTAL GAIN	One screen diameter.

(Controls not listed will have no effect on results.)

(1) Gain of vertical amplifier; a 60 cps signal, of 0.5 volt peak-to-peak magnitude, applied to Pin 3 of the VERTICAL GAIN pot R305 through a .25mf condenser results in a vertical deflection of approximately 1.75 inches. This is a measure of the performance of the video amplifier.

(2) Narrow band amplifier gain; a signal input of 64 mc (nominal), 30% modulated at a frequency of 400 cps, of 9 microvolt amplitude applied to the Display Unit RF Tuning Unit jack, J302, at the back of the chassis, yields a 1-inch vertical deflection on the cathode-ray tube screen. This is a measure of narrow band amplifier performance. (Tune signal generator for maximum output).

(3) Sweeper and Mixer: A signal input of 160 mc, of 125 micro-volt amplitude, applied to the Display Unit RF Tuning Unit jack, J302, at the back of the chassis, yields a 1-inch ver-

tical deflection on the cathode-ray tube screen. This is a measure of equipment overall performance, including the sweeper circuit.

(4) To check the alignment of the sweeper circuit and the if. amplifiers, connect a signal generator (capable of producing output over the frequency range from 148 mc to 172 mc) to the SIGNAL INPUT jack J802. As the signal generator is tuned over this range, the amplitude of the pip appearing on the screen remains within the limits of 3 db. Sweep linearity is verified by noting approximate equal horizontal pip displacement for a given frequency change. as the signal is varied.

(5) The data listed in steps (1) through (4) above is to be used in localizing trouble within the equipment. The alignment procedures described below are to be performed only after the trouble has been localized and after a check of the tubes in the equipment have been eliminated as the source of trouble. See figure 8 for the schematic circuit diagram of the complete Spectrum Display Unit.

CAUTION

On those adjustable inductors provided with locknuts, be sure to unlock the nuts before attempting to make an adjustment. Also, be sure to tighten the locknut after each adjustment.

b. NARROW BAND ALIGNMENT PROCEDURE.

(1) Test equipment necessary for alignment consists of an external signal source, capable of producing output of 160 mc cw. If desired, the self-contained beat frequency oscillator within the Spectrum Display Unit may be utilized.

(2) Slide the Display Unit out of the cabinet rack, so that all of the alignment holes, on the right side of the narrow band amplifier chassis, are readily accessible.

(3) Connect the 160-mc signal source to the SIGNAL INPUT jack J802 on the Display Unit. Adjust the output of the signal source until the signal pip is displayed. Adjust the NOISE LEVEL control, located on the top side of the narrow band amplifier, until maximum sensitivity is obtained. Vary the tuning slug of transformer T804, also located on the top side of the narrow band amplifier, until the displayed signal reaches maximum amplitude. Repeat this procedure for the tuning slug of transformer T804 which is accessible through the access hole on the right side of the narrow band amplifier chassis. The remaining transformers and inductors are to be adjusted in the above manner, and in the following order:

1st.....T803, 2nd.....L814, 3rd.....T802, 4th.....L810, 5th.....T801,	6th.....L806, 7th.....L804, 8th.....L803, 9th.....L801.

For best results, repeat the entire alignment procedure at least once. When alignment is completed, re-adjust the NOISE LEVEL control, rotating its shaft in a counterclockwise direction, in order to decrease the sensitivity until residual noise level is barely visible on the cathode-ray tube screen (with head disconnected).

c. 224 MC SWEEPER CIRCUIT ALIGNMENT.

(1) If alignment of the 224 mc sweeper circuit is required, remove the sweeper strip from the right side frame of the Spectrum Display Unit, directly beneath the narrow band amplifier. Then remove the dust cover surrounding the sides and bottom of the strip, so that the terminals on the tube sockets on the under side of the chassis are accessible.

(2) Set the FREQUENCY DISPERSION control fully clockwise, and rotate the HORIZONTAL GAIN control so that the sweep trace covers the entire width of the display screen.

(3) Remove the sawtooth input signal to the sweeper circuit by removing tube V306 from its socket. Keep the cathode-ray tube intensity low.

(4) Use a wavemeter capable of tuning within the range of 28 mc, a high-impedance vacuum-tube voltmeter, a 1-megohm resistor, and an rf voltmeter capable of indicating potentials up to 1 volt. (Such as H.P. or equivalent.)

(5) Insert the probe of the DC vacuum-tube voltmeter into the BIAS TEST pin jack, located near V-701. For proper sweep linearity, a bias voltage of about 1.7 to 3.0 volts is required. Rotate the CENTER FREQUENCY control on the front panel of the Display Unit until the proper indication is observed on the voltmeter. (See step No. 6).

(6) Place the wavemeter, tuned to 28 mc. in the vicinity of L701 at the output of V702. Tune the adjustment screws until the wave-meter indicates resonance. The inductance (L718) in the cathode circuit of V701 controls low-frequency sweep linearity, while the bi-filar winding, T701 controls sweep sensitivity. If the oscillator fails to produce an output, tubes V701 and V702 may have to be changed.

(a) After the oscillator has been properly tuned to 28 mc, connect the vacuum-tube voltmeter, through the 1-megohm resistor, to the grid of V704. Tune L702 adjustment until a maximum reading is obtained on the VTVM.

(b) Also tune L703 adjustment for maximum output.

(c) Connect the VTVM to the grid of V705 through the 1-megohm resistor, and tune L704 for maximum output.

(d) Repeat the procedure of step (a), above, for the remaining tubes V705 through V709, and inductors L705 through L711.

(e) The capacitor C738 and the tuning slug of inductor L712 are to be adjusted to give maximum amplitude of the BFO marker signal on the Display Unit screen.

(7) If the sweep is non-linear, or if the range is not covered, either reset inductor L702 for a better center frequency (28 mc), reset the bias voltage (as described in step 5, above), or vary the slugs of transformer T701 and/or of inductor L718. In general, increasing the inductance of L718 and T701 increases sweep range and sensitivity ("frequency deviation") per bias change, at the expense of weakening the output from the sweep oscillator. Be sure to reset inductor L702 after re-adjusting inductor L718 and/or transformer T701. Repeat the procedure in this step until the desired results are obtained. If necessary, change tube V701 and/or V702 to obtain satisfactory sweep linearity.

(8) Amplitude Variation: Vary the value of C738 and sweep signal across the screen noting the linearity of the amplitude. Vary C738 until a linear response is had.

SECTION III

POWER UNIT, MODEL LPU-2

1. DESCRIPTION.
(Refer to figure 5.)

a. The Model LPU-2 Power Unit is housed on a metal chassis having overall dimensions of 12-1/4 inches high by 19 inches wide by 21-3/4 inches deep, as measured from the rear of the chassis to the handles on the front panel. The unit consists of four electronically-regulated power supplies, delivering the following output voltages and current: positive 105-volt @ 200 ma; positive 150-volt @ 200 mc; positive 300-volt @ 60 ma; and negative 150-volt @ 16 ma. (See figure 9 for schematic circuit diagram.) In addition, the nominal 115-volt 50/50 cps power line voltage is fed to appropriate terminals on the TUNING HEAD receptacle and the DISPLAY UNIT receptacle at the rear of the chassis. The three positive dc outputs of the Model LPU-2 Power unit are monitored by means of a front panel meter, calibrated from 0 to 200 volts on one scale, and from 0 to 400 on a second scale. A METER SELECTOR, located directly beneath the meter, switches these voltages into the meter circuit. Screwdriver controls, at the bottom center of the front panel, are provided for adjustment of the positive voltages.

FIGURE 5. MODEL LPU-2 POWER UNIT, FRONT VIEW.

b. The Model LPU-2 Power Unit is used as the power source for the Spectrum Display Unit, for the preamplifier circuits in the RF Tuning Unit, and for the first local-oscillators in the Model LTU-1 RF Tuning Unit. In addition, the Model LPU-2 Power Unit supplies the nominal 115-volt input to the Model LKU-2A Klystron Power Unit. Protection against overloads and short circuits is provided by the 10-ampere fuses in each leg of the power line. Additional protection against shortcircuiting all positive dc power supplies is provided by a 1/2-ampere fuse in the plate circuit of the 105-volt & 150-volt series control tube, and 1/8 amp fuse in the plate circuit of the 300-volt series control tube. All operating fuses and spare fuses are accessible from the front panel.

2. OPERATING CONTROLS & ADJUSTMENT.

The operating controls and adjustments for the Power Unit, Model LPU-2 are tabulated below. All controls and fuses are mounted on the front panel.

Control	Function
POWER SWITCH	Connects the 105-125 volts, 50-60 cps, supply voltage at POWER INPUT jack J1 to the power supply and other equipment.
METER SELECTOR	Monitors the positive dc regulated output of the Power Unit at the 300 v, 150 v, and 105 v position.
VOLTAGE ADJUSTMENT	A separate screwdriver-control sets the output voltage of each positive regulated supply for the 300-volt output, the 150-volt output, and the 105-volt output.

3. SPECIFICATIONS.

Output.....6.4VAC @ 2 amp
6.4VAC @ 6 amp
6.4VAC @ 5 amp
+ 105 v @ 200 ma;
+ 150 v @ 200 ma;
+ 300 v @ 60 ma;
- 150 v @ 16 ma.

Impedance.....1.5 ohm.

Regulation.....0.2%

Ripple.....40 mv, rms. or better; 300 v supply
120 mv, rms. or better; 150 v supply
160 mv, rms. or better; 105 v supply
2 mv, rms. or better; -150 v supply

Tube Complement.....4-5R4GY; 2-6AS7G; 2-6AU6; 1-6SL7; 2-0A2; 1-6L6G.

Input.....105-125 v; 50/60 cps. 300 watts.

SECTION IV

KLYSTRON POWER UNIT, MODEL LKU-2A

1. DESCRIPTION.
(Refer to figure 6.)

a. The Klystron Power Unit, Model LKU-2A is housed on a metal chassis having overall dimension of 12-1/4 inches high by 19 inches wide by 21-3/4 inches deep, as measured from the rear of the chassis to the handles on the equipment front panel. The unit consists of two high-voltage electronically regulated power supplies. (See figure 10 for schematic circuit diagram.) The supply used for the reflector electrode of the klystron tube is at a potential of 600 volts, floating with respect to ground. It is permanently connected to the negative side of the klystron anode supply. One of three voltages is available from the anode supply, consisting of 325-volt output, 1000-volt output or 1250-volt output. The proper anode supply is selected through the use of a front panel three position switch. The switch performs two functions; changes the transformer tap to give the necessary voltage at the rectifier tube, and changes the reference voltage. When the Klystron Power Unit is energized, the reflector supply is immediately energized. A time delay relays delays the application of power to the anode supply for approximately 60 seconds. Three meters on the front panel monitor the anode supply voltage, the reflector supply voltage, and the cathode current of the klystron oscillator tube.

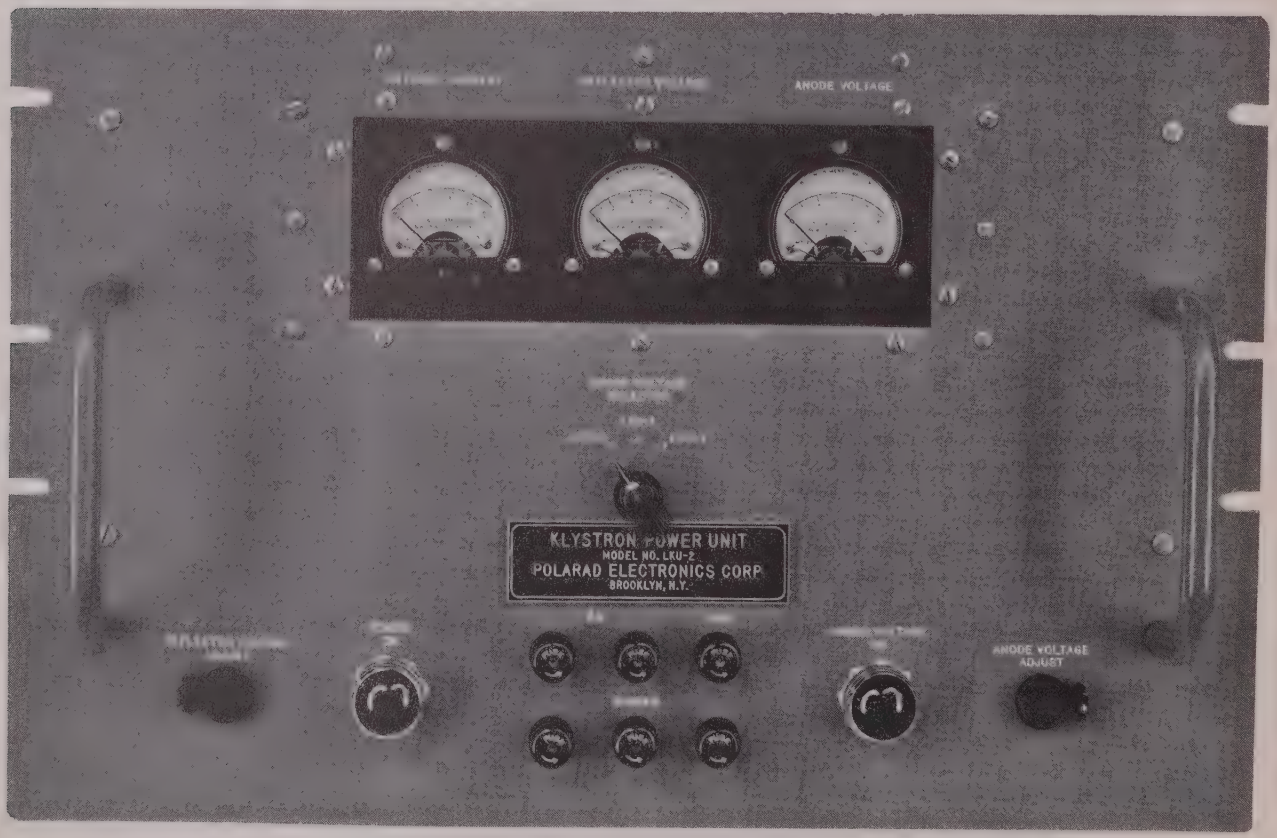


FIGURE 6. MODEL LKU-2A KLYSTRON POWER UNIT, FRONT VIEW.

b. The Klystron Power Unit is used as the power source for the reflex klystron, which is the first local-oscillator in the Model LTU-2A, the Model LTU-3 and the Model LTU-4 Tuning Units. The ac input to the unit is obtained from the Model LTU-2A, the LTU-3 or LTU-4 Tuning Units via the Tuning Unit power cable W2, from the Model LPU-2 Power Unit. The required input to the Klystron Power Unit is 105-125 volts, 50/60 cps, 300 watts, and 150 volt dc (for relay operation). The regulated and adjustable dc output voltages from the Klystron Power Unit are applied to the appropriate electrodes of the klystron tube within the RF Tuning Unit by means of the Klystron Unit power cable, W4. Protection against overloads and short circuits is provided by the 5-ampere fuses in both legs of the input to the power transformers. Additional protection against overloads in the klystron anode circuit is provided by a 1/8 ampere fuse in the plate circuit of the high-voltage series-regulator tube, V103. All operating fuses, and spares for each, are accessible from the front panel.

NOTE

THE KLYSTRON POWER UNIT IS NOT USED FOR OPERATING THE MODEL LTU-1 RF TUNING UNIT, WHICH COVERS THE 10-1000 MC FREQUENCY RANGE.

2. OPERATING CONTROLS AND ADJUSTMENTS.

The operating controls and adjustments for the Klystron Power Unit, Model LKU-2A, are tabulated below. All controls are located on the front panel.

Control	Function
REFLECTOR VOLTAGE ADJUSTMENT.	Sets the output voltage of the 600-volt regulated reflector voltage supply. (Screwdriver control.)
ANODE VOLTAGE ADJUSTMENT.	Sets the output voltage of the power supply circuit for the anode of the reflex klystron tube. (Output is 325 volts, 1000 volts or 1250 volts depending on the Tuning Unit employed) (Screwdriver control.)
ANODE VOLTAGE SELECTOR.	This three position switch selects the anode voltage 325V, 1000V, or 1250V appropriate for the Tuning Unit employed.

3. SPECIFICATIONS.

Output.....-325 v @ 50 ma, -1000 v @ 25 ma, or -1250 b @ 25 ma; 600 v @ 10 ma.

Ripple.....Less than 0.003%

Input.....105/125 v, 50/60 cps, 300 watts.

Tube Complement.....3-5R4GY; 1-6L6G; 5-0A2; 4-0B2; 2-807; 2-6AU6.

SECTION V

STARTING PROCEDURE

1. INTER-UNIT CABLING CONNECTIONS.

a. Connect the units by means of the inter-unit cables as described below. (See Inter-Unit Cabling Diagram, figure 9.)

(1) Connect Input Power cable W1 from the Model LPU-2 Power Unit Power IN receptacle J1, located on the chassis rear panel, to a 105-125 volt, 50/60 cps power source, capable of delivering 600 watts of power.

(2) Connect Tuning Unit power cable W2 from the Model LPU-2 Power Unit TUNING HEAD receptacle J2, located on the chassis rear panel, to the POWER receptacle located on the rear of the desired rf Tuning Unit.

(3) Connect Display Unit power cable W3 from the Model LPU-2 Power Unit DISPLAY receptacle J3, located on the chassis rear panel, to the POWER receptacle J301, the large multi-pin connector at the rear of the Spectrum Display Unit chassis.

(4) Connect coaxial cable W5 from the UG-291/U receptacle on the rear of the rf Tuning Unit chassis, to the UG-291/U SIGNAL jack J302, located at the rear of the Spectrum Display Unit chassis.

(5) When operating either the Model LTU-2A Model LTU-3 or Model LTU-4 RF Tuning Unit, be sure to connect Tuning Unit Klystron power cable W4 from the Model LKU-2A Klystron Power Unit receptacle J101, to the KLYSTRON POWER receptacle at the rear of the RF Tuning Unit chassis. This cable supplies high-voltage dc to the klystron-oscillator tube elements, and high-current 6.3 volt ac power to the klystron tube heater. Tuning Unit Klystron Power cable W4 is not used when operating with the Model LTU-1 RF Tuning Unit.

2. STARTING PROCEDURE.

WARNING

IF THE REFLECTOR SUPPLY VOLTAGE IS NOT PRESENT WITHIN 30 SECONDS AFTER POWER IS APPLIED, TURN THE MAIN POWER SWITCH ON THE MODEL LPU-2 POWER UNIT OFF!

a. After the POWER switch on the front panel of the Model LPU-2 Power Unit is turned ON, and while the Spectrum Analyzer is allowed to warm up for at least 10 minutes, the following indications should occur:

(1) The red pilot lamps on the front panels of all the basic units light up. The dial on the Tuning Unit in use becomes illuminated.

(2) After about 30 seconds, the voltmeter located on the front panel of the Model LPU-2 Power Unit indicates a reading. The value indicated depends on the setting of the METER SELECTOR.

(3) About 30 seconds after applying power, the REFLECTOR VOLTAGE meter at the top center of the Model LKU-2A Klystron Power Unit front panel indicates a 600-volt reading. If this meter fails to indicate a reading after the 30-second period, be sure to turn the main power switch on the Model LPU-2 Power Unit OFF, and search for the cause of trouble.

(4) About 60 seconds after throwing the POWER switch ON, a trace appears on the cathode-ray tube screen of the Model LDU-2A Spectrum Display Unit.

(5) After a delay of approximately 60 seconds, the following indications are observed:

(a) The ANODE VOLTAGE ON pilot and the ANODE VOLTAGE meter on the front panel of

the Model LKU-2A Klystron Power Unit are energized when the Model LTU-2A Model LTU-3 or Model LTU-4 RF Tuning Unit is in use. Proper meter readings are 325 volts with the Model LTU-2A Tuning Unit, 1000 volts, with the Model LTU-3 Tuning Unit, and 1250 volts, with the Model LTU-4 Tuning Unit.

(b) The CATHODE CURRENT meter on the Klystron Power Unit front panel indicates a reading of 18 ma with the Model LTU-2A Tuning Unit in use, 22 ma with the Model LTU-3 Tuning Unit in use or 22 ma with the Model LTU-4 Tuning Unit in use. After the Tuning Unit has completed its warm-up period. During warm-up, the meter will read off-scale when the Model LTU-2A Tuning Unit is in use, and high values when the Model LTU-3 Tuning Unit or the Model LTU-4 is in use.

(c) The CRYSTAL CURRENT meter, located in the upper left corner of the Spectrum Display Unit front panel, indicates a reading, except when the 10-to-100 mc band of the Model LTU-1 RF Tuning Unit is in use.

3. INITIAL ADJUSTMENTS.

a. Since proper operation of the Model LSA Spectrum Analyzer is dependent on correct initial adjustments, check adjustments in the order indicated below:

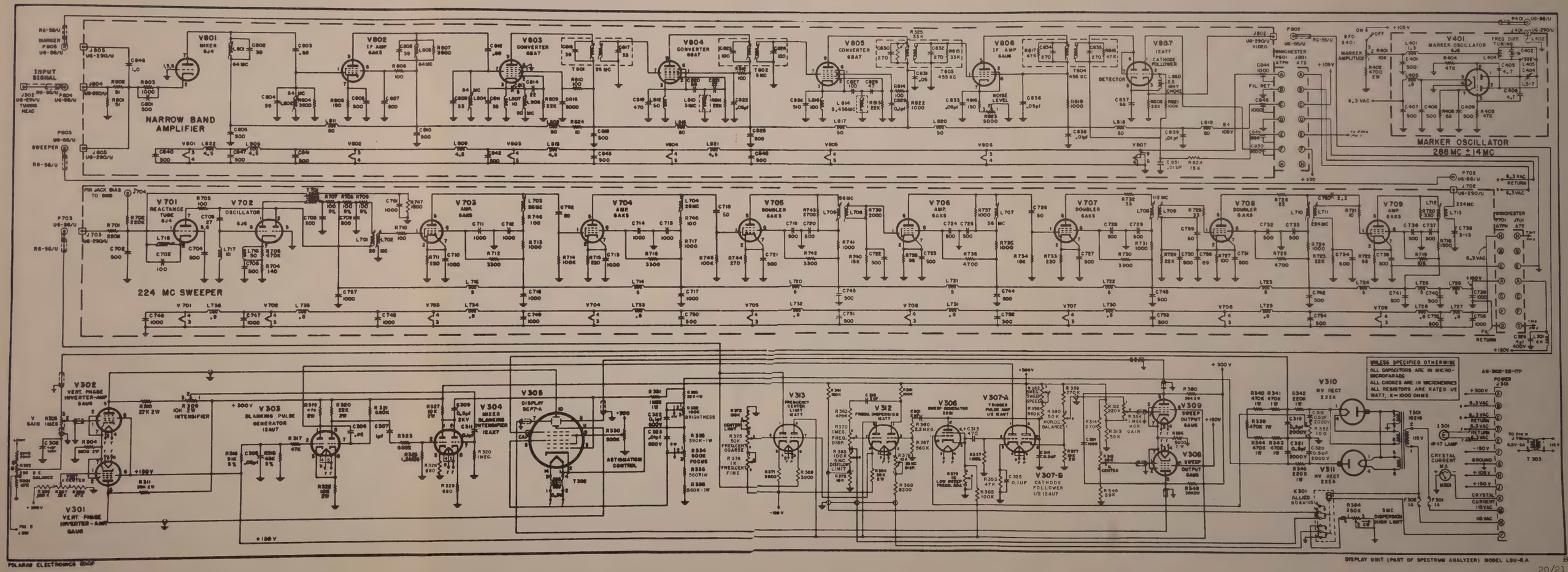
(1) FOR THE MODEL LPU-2 POWER UNIT: Rotate the METER SELECTOR to each of its positions. If the panel voltmeter fails to indicate the proper voltage at the 105 V., 150 V., and/or the 300 V. positions of the METER SELECTOR, lift the jack cover for the appropriate VOLTAGE ADJUSTMENT, insert a screwdriver and rotate the adjustment screw counter-clockwise; then approach the desired voltage-setting in a clockwise direction.

(2) FOR THE MODEL LKU-2A KLYSTRON POWER UNIT:

a. If the voltmeter fails to read 600 volts when the Klystron Power Unit is on, lift the jack cover over the REFLECTOR VOLTAGE ADJUSTMENT panel marking, and insert a screwdriver. First rotate the adjustment screw in a counter-clockwise direction. Then approach the desired 600-volt setting by rotating the potentiometer arm in a clockwise direction.

b. ANODE VOLTAGE of the reflex klystron oscillator is indicated on the right-hand panel meter. If the voltmeter fails to indicate the proper voltage, lift the jack cover over the ANODE VOLTAGE ADJUSTMENT, then rotate the adjustment screw in a counter-clockwise direction first, and approach the proper voltage setting in a clockwise direction.

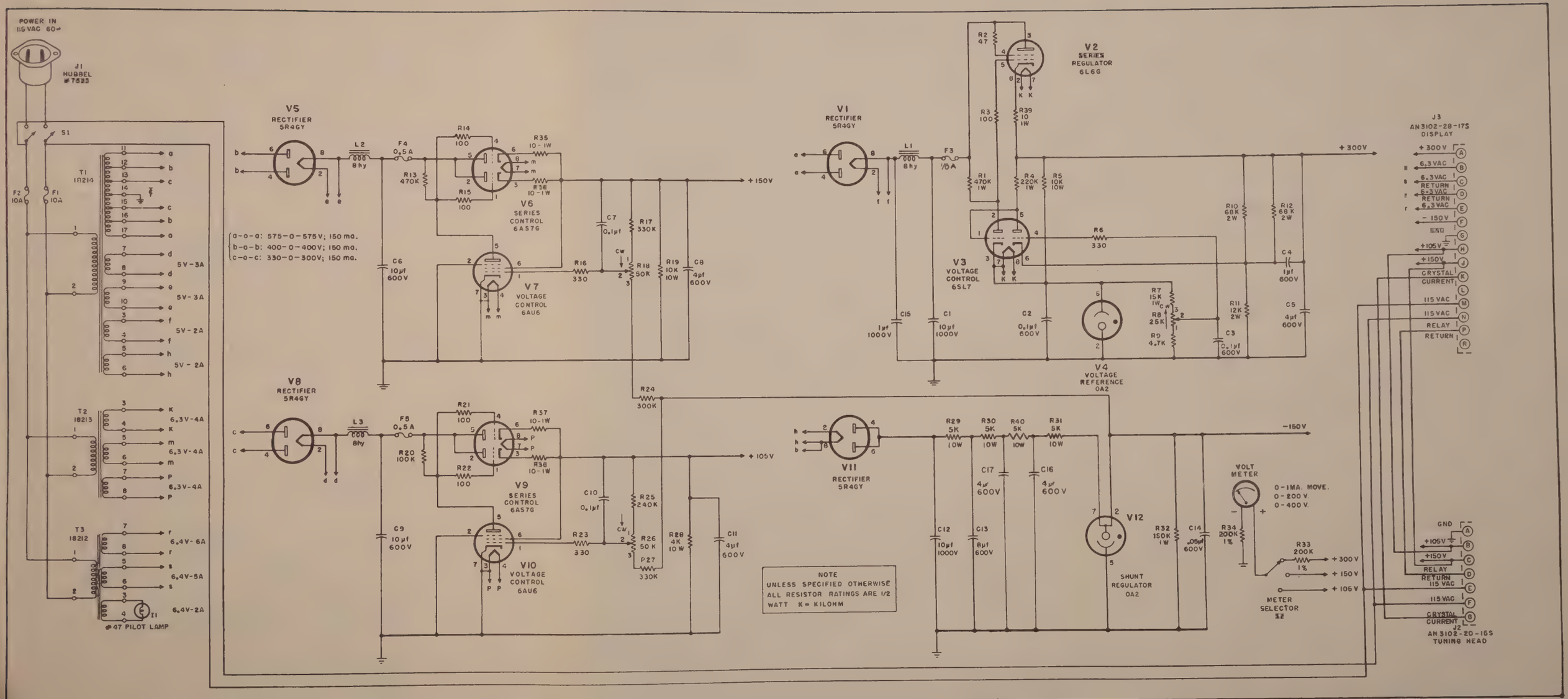
(3) FOR THE MODEL LDU-2A SPECTRUM DISPLAY UNIT: A sweep trace appears on the cathode-ray tube screen of the Spectrum Display Unit within approximately 60 seconds after turning the POWER switch on the Model LPU-2 Power Unit on. If no trace appears within a reasonable time, adjust the BRIGHTNESS, FOCUS, HORIZONTAL GAIN, and VERTICAL GAIN controls until a desirable trace appears.



POLARAD ELECTRONICS GROUP

DISPLAY UNIT (PART OF SPECTRUM ANALYZER) MODEL LDU-2A

B



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MODEL LPU-2 POWER UNIT (PART OF SPECTRUM ANALYZER) SCHEMATIC DIAGRAM 211-2

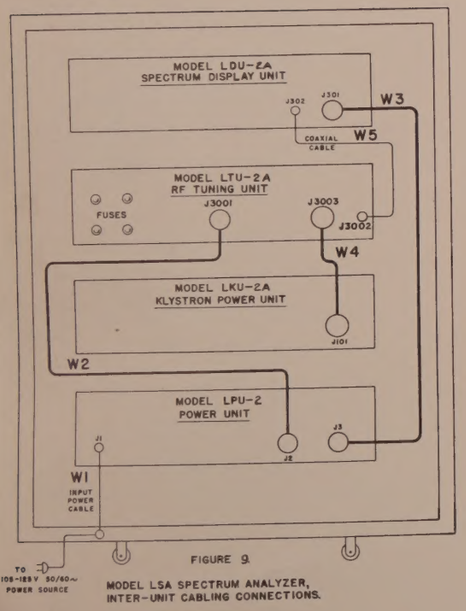
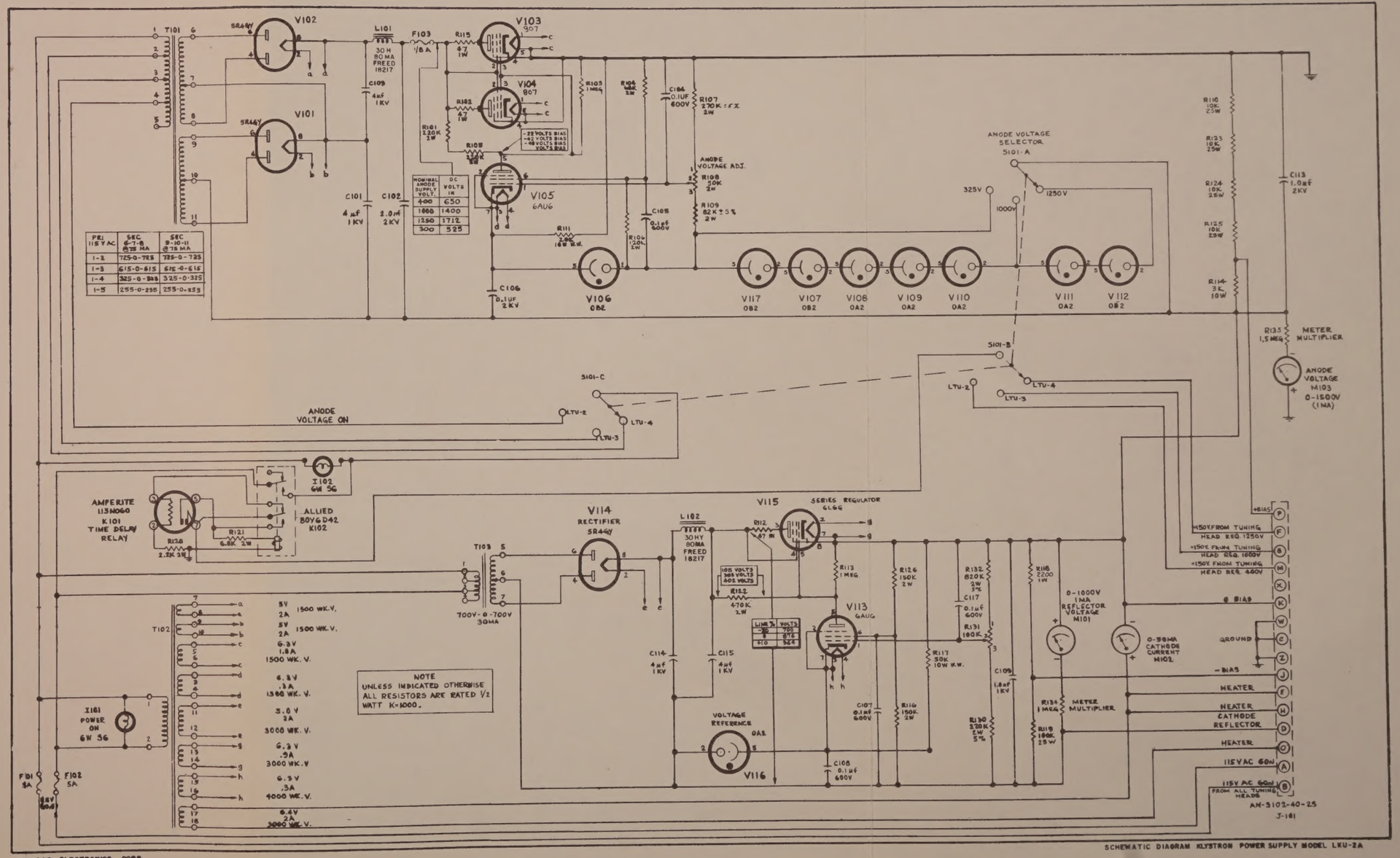


FIGURE 9.

MODEL LSA SPECTRUM ANALYZER, INTER-UNIT CABLING CONNECTIONS.

FOR 940-4500 MCS.



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SCHEMATIC DIAGRAM KLYSTRON POWER SUPPLY MODEL LKU-2A